APPENDIX B

METHOD AND DEVICE FOR CONVERTING HEAT ENERGY INTO MECHANICAL ENERGY

Field of Invention:

The present invention relates to a process of the conversion of heat energy into mechanical energy by means of changing volume, pressure and temperature of the work medium, primarily gas in number of steps, and simultaneously relates to an apparatus for performing the process.

Background to the Invention:

There are known concepts of the conversion of heat energy into mechanical energy, where temperature and pressure is changed in the workspace with alternately changing volume. As the volume decreases, temperature and pressure increase both due to this volume change and primarily, in the last stage, due to the volume decreasing, or optionally, in the first stage due to the volume reincreasing, by the additional supply of heat energy either from the exterior, or from the heat generation (e.g. combustion) inside the workspace. As the volume reincreases, the pressure (originated from the previous workspace volume decreasing), after loss deduction, performs the work needed for consecutive volume decreasing. While the pressure, originated from the additional heat energy supply, after the loss deduction, performs the resulting mechanical work. At the permanently closed work space concept, the work medium temperature (due to the additional heat energy

supply) would be, at the end of the operating cycle, greater than the temperature at the beginning of the previous volume increasing. So that, during an exterior heat supply, the medium temperature would reach the temperature, where the heat is supplied from the exterior and the temperature difference and also volume of the supplied heat would be, without a view to the losses, zero. The heat supply, developed in the medium, would stop due to the lack of oxygen, at the permanently closed workspace. It is therefore necessary to open the workspace for the used medium exhaust and the fresh medium supply for a certain time, namely both at the beginning of the volume decreasing, or before it and at the end of the volume increasing, or after it. The power cycle of the pressure and temperature variations, during the volume increasing and decreasing, proceeds in two stages. If there are other two stages added to the previous ones (i.e. volume increasing for the used medium supply and volume decreasing for the used medium exhaust) then there is the four-cycle process of the conversion of heat energy into mechanical energy implemented. If the medium supply and exhaust take place at the beginning of the first stage, or respectively at the end of the second stage, then the two-cycle process is implemented. All of these processes take place according to the known state of art in one workspace, exceptionally divided into two parts.

Summary of the Invention:

According to the present invention, work medium is sucked to the conversion of heat energy into mechanical energy by means of pressure and temperature change of

the work medium into the first stage chamber simultaneously with the volume increasing of this stage chamber, whereby it transfers into the second stage chamber during the first stage chamber volume decreasing, whereby it transfers (during the second stage chamber volume decreasing) through the third stage chamber, simultaneously with the fourth stage chamber heat supply and simultaneously with this fourth stage chamber volume increasing, whereby it transfers from the fourth stage chamber (during its stage chamber volume decreasing) into the fifth stage chamber, where it is permitted to expand. The concept according to the present invention is described by the transfer of work medium through the third stage chamber simultaneously with the second stage chamber decreasing, simultaneously with warming, into the fifth stage chamber, or can be described by cooling during the transfer of the medium through the first stage chamber into the second one. Another aspect of the present invention is that the work medium is transferred, simultaneously with its cooling, from the fifth stage chamber into the first stage chamber simultaneously with this first stage chamber volume increasing. The concept can be, according to the present invention, modified so that the work medium is transferred from the fifth stage chamber, simultaneously with its volume decreasing, into the third stage chamber and is used for the warming process, or that the fifth stage chamber is joined with the first stage chamber and simultaneously with decreasing of the volume of this joined stage chamber is work medium (optionally with the simultaneous cooling) transferred directly into the second stage chamber, simultaneously with increasing the volumes of this second stage chamber. The apparatus for

a multistage chamber conversion of heat energy into mechanical energy by means of changing volume, pressure and temperature of the work medium has the third stage chamber in form of a workspace with an invariable volume, while the other stage chambers are arranged as workspaces with variable volume (particularly as piston machines with the revolving piston) and are functionally, in a way of the work medium transfer, arranged one behind the other, partly before the third stage chamber and partly behind the third stage chamber. The apparatus for performing the present invention is further adapted in a way, so that the largest volume of the first stage chamber is larger then the largest volume of the second stage chamber, while the largest volume of the fifth stage chamber is larger than the largest volume of the fourth stage chamber, while the largest volume of the fifth stage chamber is larger than the largest volume of the first stage chamber or equal to the largest volume of the first stage chamber. The apparatus, according to the present invention, can be furthermore arranged, so that the fifth stage chamber concurrently forms the first one. According to another aspect of the present invention, the third stage chamber is created as a combustion chamber and/or a heat exchanger. The present invention is furthermore expediently adapted so that the fifth stage chamber is equipped by the inlet valve. According to this aspect of the present invention, the cooler is inserted between the first stage chamber and the second stage chamber, and also between the fifth stage chamber and the first stage chamber and also between the joined stage chamber and the second stage chamber.

Brief Description of the Drawings:

The present invention is readily understood from the Drawings, in which:

Figure 1 shows an apparatus of the present invention;

Figure 2 shows a version with the cooler between the first stage chamber and the second stage chamber and also between the fifth stage chamber and the first stage chamber in accordance with the present invention; and

Figure 3 shows a concept with the first stage chamber joined together with the fifth stage chamber and a concept with the cooler between the fifth stage chamber and the second stage chamber in accordance with the present invention.

Detailed Description:

Work medium is brought into the first stage chamber 1 during the first stage chamber volume increasing, as in Figure 1, whereby it is, during the first stage chamber 1 volume decreasing, it is transferred into the stage chamber 2, simultaneously with its volume increasing. It is then, during the second stage chamber 2 volume decreasing, transferred into the third stage chamber 3. While transferring through the third stage chamber 3, heat is supplied into work medium either from inside by fuel combustion, or from outside by the third stage chamber heating e.g. by exterior combustion. Work medium is transferred from the third stage chamber 3 into the fourth stage chamber 4, whose volume simultaneously

increases, whereon it is, from the fourth stage chamber 4, concurrently with its volume decreasing, transferred into the fifth stage chamber 5. In this fifth stage chamber 5, the work medium is allowed to expand within its volume increasing. Work medium is after its expansion, concurrently with the fifth stage chamber 5 volume decreasing, either conducted outside, or inside back into the first stage chamber 1. When using air as a work medium and exterior combustion as a concept of the heat supply into the third stage chamber, it is convenient to use expanded, but hot, air for the inside combustion. The present invention therefore presents five-cycle thermo dynamical cycle. These can be convenient, in some cases, to avoid the fourth stage chamber 4 and to transfer work medium into the fifth stage chamber and allow it to expand in this stage chamber. It is convenient, when work medium is cooled inside the interstage cooler 6, during its transfer from the stage chamber 1 into the second stage chamber 2 (see Picture 2). In the closed cycle, where the work medium is transferred from the fifth stage chamber 5 back into the first stage chamber 1, it is convenient to insert other interstage cooler 7 between the fifth and the first stage chamber. It is also convenient, in some cases, according to the other invention concept, to join the fifth and the first stage chamber into the joined stage chamber 51 and to transfer (during this joined stage chamber volume re-decreasing) work medium, expanded during the joined stage chamber 51 volume increasing, into the second stage chamber 2, simultaneously with this second stage chamber increasing, optionally through the joined interstage

cooler 76. The basic five-stroke cycle is, in this case, adapted into the three-stoke cycles.

The apparatus, as described above, performing the conversion of heat energy into mechanical energy is according to the invention, arranged in a way, so that the third stage chamber 3 composes from, at least, one workspace with an invariable volume, while the other stage chambers 1, 2, 4, 5, 51 are created as workspaces with the variable volumes. It is convenient to create all the stage chambers, excluding the third one, as piston machines with the revolving piston. Where the cusps edges join together during the piston revolution above each plane, the space volume may be enclosed by this area and the inclined inside cylinder plane, where the piston revolves in, decreases. Here, the largest volume of the first stage chamber 1 is larger than the largest volume of the second stage chamber 2, and furthermore, the largest volume of the fifth stage chamber 5 is larger than the largest volume of the fourth stage chamber 4 and the largest volume of the stage chamber 5 is larger than the largest volume of the stage chamber 1. The largest volume of the joined stage chamber 51 is larger than the largest volume of the stage chamber 4 and also larger than the largest volume of the stage chamber 2. The third stage chamber 3 is created as a combustion chamber and/or as a heat exchanger. Work medium is firstly supplied (e.g. by sucking) into the increasing volume of the first stage chamber 1. After reaching maximum, the volume of this stage chamber begins to decrease and work medium is exhausted into the increasing volume of the second stage

chamber 2. Because the largest volume of the second stage chamber is many times smaller than the largest volume of the first stage chamber 1, the state of work medium changes so that, after its shift from the first stage chamber 1 into the second stage chamber 2, this medium has higher pressure and also higher temperature. If the temperature increase is not desirable, it is possible to insert the interstage cooler 6 between both of the stage chambers according to the Figure 2. When the volume again decreases in the second stage chamber 2, work medium is transferred from it through the third stage chamber 3 into the fourth stage chamber 4, while increasing its volume. Heat is supplied into work medium in the third stage chamber 3 either by inside combustion, where the stage chamber is made as a heat exchanger, or by inside combustion in a way of the combustion in the turbine's combustion chambers, but under considerably higher pressure. Because the largest volume of the fourth stage chamber 4 is generally equal to the largest volume of the second stage chamber 2, work medium has in the fourth stage chamber 4, after warming in the third stage chamber, in the final state, higher pressure and also higher temperature contrary to the initial state in the second stage chamber 2. Work medium expands from decreasing volume of the fourth stage chamber 4 into increasing volume of the fifth stage chamber 5, where it performs work. It is also possible to adapt this apparatus according to the present invention, so that the largest volume of the fourth stage chamber 4 is larger than the largest volume of the second stage chamber 2, so that the partial isobaric to isothermal expansion between both of the stage chambers will occur and this adaptation will reach

Carnot's cycle concept. In an extreme case, it is possible to completely avoid the fourth stage chamber and to let work medium expand from the second stage chamber 2, during warming in the third stage chamber 3, into the fifth stage chamber 5. The third stage chamber has a nonzero volume so that, if there is no heat supplied, the partial expansion occurs at the beginning of the work medium transfer and after transferring through the third stage chamber into the fourth stage chamber, work medium has lower pressure and also lower temperature then in the second stage chamber. However, due to this lower pressure, the fourth stage chamber takes proportionally lower weighted quantity of work medium than it is supplied into the third stage chamber from the second stage chamber and the residual quantity generates, or optionally increases, the residual pressure in the third stage chamber. According to the size of the third stage chamber, in this manner also without heat supply, the pressure in the third stage chamber very quickly rises, so that expansion, within the work medium transfer from the second stage chamber into the third stage chamber, does not occur and it is possible to supply heat under the pressure given by compressed work medium from the first stage chamber into the second stage chamber. It is therefore possible to dimension the third stage chamber both as a combustion chamber with a small external area, so that needles heat leak does not occur, and as a heat exchanger with a large area, so that it is possible to supply the largest heat quantity possible. In order to supply the largest possible heat quantity into the third stage chamber and to decrease the work expended during the compressional stage chamber of the cycle, it is, if possible, needed

to decrease temperature during the transfer from the first stage chamber into the second one. It is, according to the present invention, enabled by inserting the interstage cooler 6 between the first stage chamber 1 and the second stage chamber 2. At the enclosed cycle, where work medium is transferred from the fifth stage chamber 5 back into the first stage chamber 1, it is appropriate to insert an innerstage cooler 7 between these two stage chambers. At the configuration according to the invention, it is possible to choose, independently upon the compression ratio, magnitude of the expansion ratio, so that it is possible to expand compressed to the pressure of the surrounding environment and heated work medium, whereby a good cycle efficiency is reached. At the given expansion ratio, the pressure at the end of the expansion is given by magnitude of the pressure at its beginning and this pressure, at the end of the expansion, can therefore, at the smaller heat supply, drop under the surrounding environment pressure. If this phenomenon is not desirable, it is possible to incorporate other inventive aspects i.e. additional work medium inlet through the inlet valve 8 at the end of the expansion. The power cycle, realized according to the present invention and apparatus, is therefore five-stroke cycles. At certain expansion ratio magnitude in the fifth stage chamber 5 (i.e. the ratio between the largest volumes of the fifth and fourth stage chambers), not only the pressure at the end of the expansion, but also the temperature drops to the value of the surrounding environment. It is therefore possible at the enclosed cycle and at the outside work medium warming, which take place in the third stage chamber 3, according to the other invention

character, to join the fifth stage chamber 5 with the first stage chamber 1 according to Figure 3 and to transfer work medium after expansion in the convenient way from the joined stage chamber 51 through the interstage cooler 76 into the second stage chamber 2 concurrently with its compression. In this case, it is also desirable to equip the joined stage chamber 51 by the inlet valve 8. It is therefore possible, in some cases, within the invention, to adapt the five-stroke cycle to the three-stroke cycle.

The present invention is, both according to the design examples mentioned previously and in comparison to the other known heat engines, more convenient especially by its possibility to allow higher working pressure and temperature then turbine engines, longer warming of the compressed work medium and lower pressure and temperature at the end of the expansion then so far know piston engines. Higher cycle efficiency, lower emissions of the carbon and nitrogen oxides, lower noise in the case of work medium warming by external or internal combustion is the outcome of the present invention. It is also possible to use the present invention for the conversion of solar energy into mechanical energy.